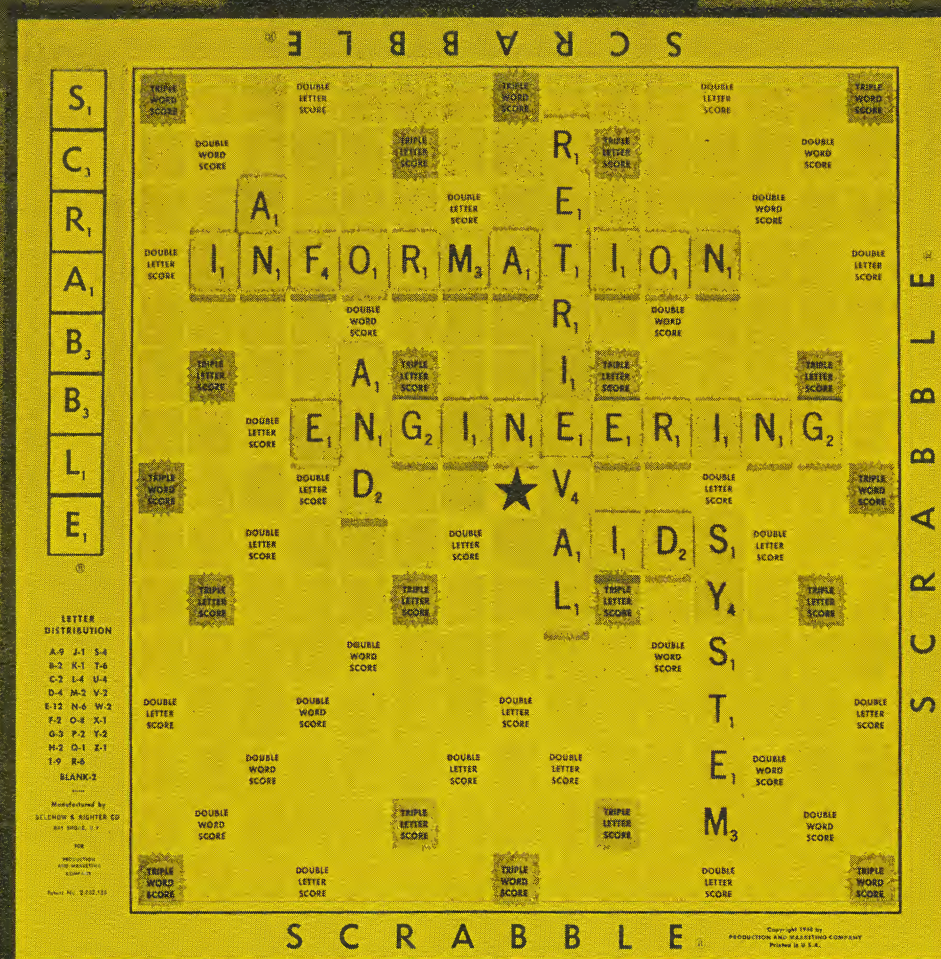


CSC REPORT



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AN INFORMATION RETRIEVAL AND ENGINEERING AIDS SYSTEM

By E. Barnes, Houston Division

The immense volumes of engineering data generated in the development and construction of Manned Spacecraft Systems have necessitated the creation of extensive information storage and retrieval systems. The Manned Spacecraft Center of NASA has undertaken the task of accumulating comprehensive engineering information on the thousands of parts and assemblies that will be used on the Apollo Spacecraft Program. The data involved include complete descriptive information of development, test, and flight models, as well as ground support equipment. Descriptions of the assemblies and parts required include references to part numbers, manufacturers, applicable construction and test specifications, and, of greatest importance, the bills of material or engineering parts lists. This information must be maintained in such a fashion that both the parts lists and the where-used data may be retrieved for any assembly or part. In addition to the descriptive information, the files contain data on test and qualification status, design configuration, as-built configuration, failure, documentation control indexes, engineering orders and completions, reliability, and contractor and manufacturer identification.

From this mass of technical data, the Manned Spacecraft Center has requirements for fast access to various types of reports. In the event that defective parts or assemblies are discovered, each of these parts must be traceable to its location and function. Engineering parts lists of all the parts and assemblies that are installed in each model of each section of the spacecraft must be prepared. Where-used lists must be available showing the assemblies and models in which each part is used.

The reliability and expected life of each part in the spacecraft must be known and lists must be prepared of critical items whose effective usefulness is terminating. The reliability and quality assurance program requires extensive testing and qualification. The status of the qualification of each assembly must be maintained and reported. A vast amount of data is being compiled



Mr. Barnes is an expert in the design, development, and programming of large-scale information retrieval systems. Prior to joining CSC in September of 1964, he was employed in similar positions by Control Data Corporation, Bendix Computer Division, and the Programming Staff of the U.S. Army Chief of Staff for Intelligence. He holds a BS in Mathematics from Northwestern State College.

from the testing program and reports of the acceptability and preference of the parts, materials, and manufacturing processes will be made available. The collection and maintenance of the qualification and preference data for the Apollo Spacecraft Program marks the first time that this type of information has been made accessible for following spacecraft programs. The centralization of the information storage and retrieval system will provide unlimited benefits in contractor coordination; selection of engineering materials, parts, or processes; and detailed knowledge of the product structure of each assembly and model to be used in the Apollo program.

Computer Sciences Corporation has been commissioned to design and program this comprehensive information storage and retrieval system. To be included in the system are the various engineering aids as outlined above. The designed system will accept input data in the form of punched cards and magnetic tape of various formats furnished by the five major contractors to the Apollo Spacecraft Program. The system consists of four major phases:

1. Input Processor
2. Master File Update
3. Generation Breakdown
4. Data Retrieval and Report Generation

Input Processor

Since the source information received from the contractors is not yet supplied in a standard format, each input must be processed by an editing routine to construct compatible internal formats for use by IR and EA System. Each contractor furnishes input to update five different information files. In this phase of the system a key field validation is performed, checking such items as contractor, types of record, and other coded information.

Any gross errors are removed from the file being generated and are listed from the error tape. After human analysis of the

hard-copy listing of errors, corrected items are entered into the update portion of the validation and reformatting phase, resulting in a validated input data file.

Master File Update

After the initial generation of each file, in which a master file is produced, all other inputs of an updating nature such as adding, replacing, or deleting data to the current master file are used to generate a new master file which can be processed by the total IR and EA System.

Data Retrieval and Report Generation

The major key to any information and retrieval system is the capability of selective retrieval of data records and the flexibility for variable data and report formatting for all data files within the system. This is especially critical in the Apollo IR and EA System due to the massive volume of technical data involved and the relative inability to foresee the exact data or types of reports required at future times.

To provide for maximum flexibility, the Data Retrieval and Report Generator phase of the IR and EA System has been designed in three main segments as follows:

- Selective Extraction of Data Records

- Variable Sorting Routines

- Fixed and/or Variable Report Formatting

The extraction segment provides variable extraction capabilities for all data files in the system. Special multi-report facilities allow extraction on from one to five separate reports during a single pass over the input data. Extraction can be based on any data field within any of the input files. Within any one report, the user may specify extraction on from one to eight different data fields using "OR" logic for multiple extraction values within a field and "AND" logic for values between the various data fields. Up to 175 extraction values may be specified for each report.

After the extraction segment has been completed, the intermediate output data files may be sorted to any desired sequence prior to final report formatting. The user has the option of specifying sorting procedures for one or all reports being produced.

The final report generation segment consists of decoding and formatting the selected data into fixed and/or variable report formats. The fixed formats were designed to produce printed lists such as the Apollo Where-Used Parts List, the Apollo Engineering Order Parts List, and other reports considered necessary for routine review by NASA personnel. However, since it is impossible to foresee the exact future reporting needs, it is anticipated that the variable reports will be of immeasurable value as the Apollo program progresses. Therefore, considerable effort was expended on developing variable-formatting routines which let the user select the specific data to be printed and the exact sequence in which the data are to appear on the final report. The variable-formatting routines provide complete data heading descriptions and allow up to 11 data items to be printed for each report, using two or three data lines as necessary. The user also has the ability to supply a one- or two-line heading for each variable report.

These three segments of the Data Retrieval and Report Generation phase provide NASA personnel with a maximum degree of flexibility to meet present and future requirements for the Apollo program.

Generation Breakdown

Generation breakdown, often referred to as a generic listing of parts or a parts explosion, provides for the generic breakdown of parts for a spacecraft, major component, etc., showing the

relationship of each part to its next higher and lower components.

The design of the files is of major importance in achieving efficiency in the retrieval of a set of structured data, such as the parts and assemblies in the spacecraft. The files are maintained in part-number sequence. The record describing an assembly is actually a set of records consisting of a header record and a group of trailer records which describe the parts and subassemblies that go to make up the assembly. Each header or basic product record also contains information linking it to its next higher or lower assembly. Because each part and assembly is chained in this manner, it is possible to create parts lists that show the structure of the products from the largest assembly to the lowest part, as well as all assemblies and subassemblies in which each part is used.

By using this "Where-Used List," it is possible to trace each part to the exact system in which it is used.

By use of a mass storage random access device (disk) and a retrieval technique developed by Computer Sciences Corporation, only *one* pass of any one file is required to produce a complete generation breakdown of parts.

By use of "complex level indicators," it is necessary to retrieve each record from the disk only once to achieve a generic breakdown of parts. Complex level indicators are a means of assigning level numbers to each record as it is retrieved in such a manner that it becomes unnecessary to re-orient the record as successive levels are extracted.

The generic breakdown of the engineering parts file and the configuration and traceability file are similar in that they both show the relationship of each part to its next higher or lower component. The only difference is that the configuration and traceability file contains data used in configuration accounting, which represents the current physical configuration of assembled components in the spacecraft; whereas, the engineering parts file represents the planned design for the craft. As a final product of the IR and EA System, the engineering parts file is compared to the configuration file, allowing the user to correlate the design configuration versus the as-built configuration. This type of cross-checking not only reveals changes from design in construction of the spacecraft, but supplies a historical review of documents generated in making the changes. These can be evaluated for redundancy and errors, and provide a basis for future designs.

While the system was designed for sequential processing because of the tremendous volume of data involved, there will eventually be economically justifiable requirements for real-time retrieval of engineering information. Therefore, the next logical step in the future development of the IR and EA System is the design and implementation of mass memory random accessible storage and on-line data collection and inquiry stations.

With the great versatility of the IR and EA System, it is possible to maintain all current data on parts and materials on the Apollo Spacecraft Complex, and realize tremendous savings of time and money on future projects. With the mass of data now being collected, such things as preferred parts lists, testing and qualification criteria, and document control procedures can be implemented on future space vehicles. The preferred parts list will represent an approved set of parts and materials known to be reliable and available to perform certain functions common to other spacecraft. When new parts are needed for a system, the history of testing and qualification criteria will be very useful in determining specifications for evaluation of similar parts by contractors. Last, but not least, is the valuable experience gained in the retrieval and indexing of the mass of documents generated in a program of this size.

CSC TO ACQUIRE SICHAK ASSOCIATES

Computer Sciences Corporation has announced an agreement for the acquisition of Sichak Associates of Nutley, New Jersey. CSC will issue an undisclosed amount of its common stock for all the issued and outstanding shares of Sichak Associates.

Sichak Associates was formed in June 1961 to offer engineering services to the government and industry in the field of communication systems design and consulting. In addition, Sichak has produced electronic components for use in industrial process control equipment.

Upon completion of the acquisition, Sichak Associates will become part of Communication Systems Incorporated of Paramus, New Jersey, a wholly-owned subsidiary of CSC.

NAME NEW HEAD OF SERVICE BUREAU

Maurice P. Chrysler has joined CSC as Manager of the Service Bureau Division.

Mr. Chrysler was formerly Director of Data Processing Operations for the Northrop Corporation in Hawthorne, California, and is widely recognized for his many contributions in the application of computers to the total spectrum of data processing activities. He replaces Dan Mason, who recently accepted an assignment as Head of COMPUTAX Corporation, a recently formed subsidiary of CSC and Commerce Clearing House, Inc.

With over ten years in computer facility management, Mr. Chrysler's other experience includes service with Shell Oil Company as Manager of Data Processing; Arthur D. Little, Inc., as data processing consultant; Univac as a service center consultant; and Collins Radio Company as Manager of Operations and Programming. He holds an MS in Mathematics from Kansas State University.



On August 10 CSC played host to three foreign exchange students and their student guides who were touring the country sponsored by the Ambassadors for Friendship program. The students, reading from right to left in the picture, are: Mie Nakatsu, from Kyoto, Japan, a nurse, who majored in psychology at the College of St. Catherine in St. Paul, Minnesota; Thorunn Olafsdolter, from Iceland, majoring in art at Ohio State University; and Michelle Rabemanantsoa, from Madagascar, majoring in political science at Macalester College, St. Paul, Minnesota, who plans to return to Madagascar to work for the government as a social worker. Their host while in Los Angeles, CSC's Al Stern, is explaining the computer operation to them.

CSC DIRECTORS APPROVE STOCK SPLIT

CSC's Board of Directors has approved a split of the company's stock, five shares for each two shares currently outstanding. The directors' approval included an increase in the dividend rate to \$.02 per share per quarter on the new stock when the split becomes effective.

The directors' action is subject to the approval of regulatory agencies and a majority of the shareholders. Effectivity date of the split and dividend increase will be announced as soon as formal approvals have been obtained.

UNIVAC 1107 INSTALLED IN NORTHWEST DIVISION

CSC's Northwest Division, located in Richland, Washington, has installed a UNIVAC 1107 computer for service to the AEC's Hanford Atomic Products Operation and other firms throughout the Pacific Northwest.

Since taking over the data processing functions at Hanford earlier this year, the division has utilized the REMOTRAN system to remotely process a variety of programs on CSC's other 1107 in El Segundo.

CSC EXPANDS PLANS AND PROGRAMS STAFF

Three senior appointments to the Plans and Programs staff at Computer Sciences Corporation were announced last month. Wesley E. Niemond was named Manager, Plans and Programs for the Los Angeles Division; Jack R. Lohrey, Manager, Plans and Programs for the San Francisco Bay Area; and W. O. Wilson, Manager, Plans and Programs for the Northwest Division.

Mr. Niemond comes to CSC from the Librascope Group of General Precision, Inc., where he was Manager of Command and Logistic Systems Marketing. Prior to his association with Librascope, he was employed by System Development Corporation, Stromberg Carlson, and Hughes Aircraft Company in various corporate planning, management, and technical support positions. He is a graduate of the Northrop Institute of Technology and attended the University of Pennsylvania.

Mr. Lohrey's most recent position was as Regional Manager of Marketing for the San Francisco Center of C-E-I-R, Inc. He was formerly associated with the Philco Western Development Laboratories in Palo Alto and International Business Machines in San Francisco in various sales positions. A graduate of Stanford University in Economics, Mr. Lohrey is active in the National Machine Accounting Association and the Association for Computing Machinery.

Mr. Wilson was employed by the IBM Service Bureau Corporation as a Marketing Manager since 1963. Prior to this, he held a variety of sales and engineering posts with Computer Engineering Associates, Doering Engineering Company, Northrop, and the Garrett Corporation. He holds a BS in Business Management from the University of California.

CSC REPORT — SEPTEMBER 1965
Published by Computer Sciences Corporation
650 North Sepulveda Boulevard
El Segundo, California 90245
San Francisco/Houston/Washington/London
New York/Richland, Wash.